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Dual-channel GPR surveys of No.12 Glacier, Laohugou valley, Qilian Mountain, Western China: ice thickness and internal structure

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The inner-structures of glacier were analyzed from the profile images of an impulse dual-channel ground penetrating radar (DCGPR) for No. 12 Glacier, Laohugou Valley, Qilian Mountain, Western China. Common-offset reflection survey was adopted in measuring several survey lines with dominant frequencies of 150MHz and 500MHz simultaneously. The profile images were obtained by very slow hand-towing at a speed of about 0.5m/s, and were recorded at a range of 20000 ns, with 8192 samples/trace and 16 bit/sample. The profiles were recorded at an effective rate of only 3 traces/s because a dynamic, running stack was needed to lower the signal to noise ratio and make the stratigraphy visible.

Based on the amplitude and the phase fluctuations in the single waveforms, as well as the echo and other texture features in B-Scan images of the radar signals, the location and the scale of continuous multi-interface or the structural characteristics of the discrete mutation were identified from the low frequency and high frequency channels. The elevation of the profile was about 4200m to 4500m above sea level, and the apparent bottom reflection indicated the maximum ice thickness is about 152m. Part of radar images combined with the known geological information informed that caves, caves with water, channels beneath the ice, and debris layers between glacier and bedrock existed in glacier. The analysis showed that even in a typical continental alpine glacier, there may exist more complex internal structures and strong basal erosion processes.

The experiment results suggested that the GPR is capable of sounding the depths and profiling the stratigraphy of valley glaciers. Most significant is its ability to respond to the weak stratification of physical or chemical contrasts, which caused by changes in density, ice fabric and conductivity. The lower-frequency radar is well suited for detecting the depths of the glacier by overcoming the attenuation action of water for radar signal, while the higher-frequency radar can profile englacial strata of shallow layers and produce better resolution.